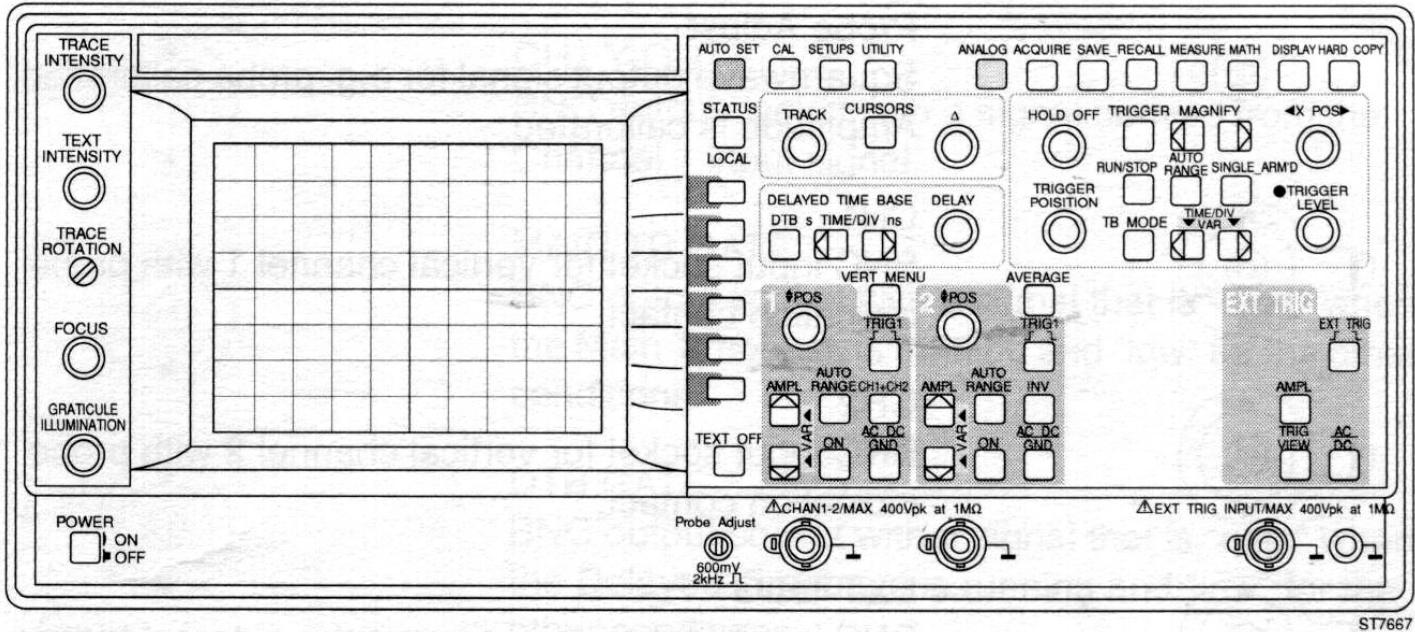


**Laboratory Procedure:**Figure 1: Fluke PM3380A Autoranging CombiScope Instrument<sup>[1]</sup>**GETTING STARTED**

1. Turn on the Fluke PM3380A Oscilloscope (Fig. 1) and the PM5139 Function Generator.
2. Attach one BNC from the output of the function generator to Ch1 of the scope.
3. Attach a second BNC from Ch2 of the scope to the TTL output in the rear of the function generator. The TTL output provides a periodic pulse waveform.

**ANALOG AND DIGITAL MODES**

This instrument is a combination of an analog real-time oscilloscope and a digital storage oscilloscope, which offers a variety of additional features. The combination of analog and digital modes in one instrument gives you the advantages of both modes.

In the **ANALOG MODE** the signal is directly written on the screen. The result is the "traditional" real-time signal representation. Because of the high update rate and infinite resolution, this image gives signal details that are visible only on true analog oscilloscopes.

In the **DIGITAL MODE** the input signal is sampled. These samples are stored in memory so that mathematics, calculated measurements, printing, and other memory functions can be performed on the trace.

Figure 2: Fluke PM3380A User Manual page 4-9<sup>[1]</sup>

More than likely, the amplitude, frequency, and perhaps even the waveform of the function generator is in some arbitrary configuration. Press the **ANALOG** button several times until you can distinguish analog mode from digital mode. Leave the scope in analog mode.

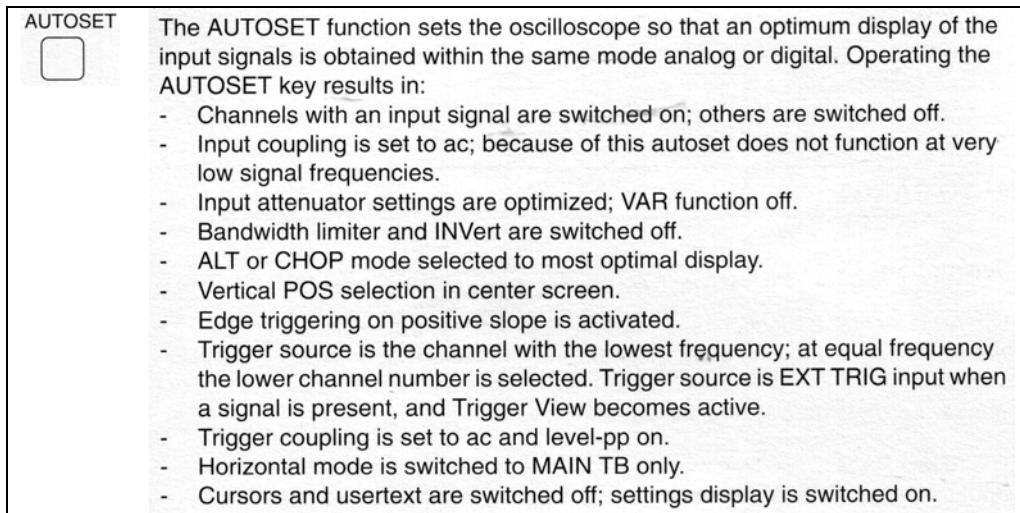
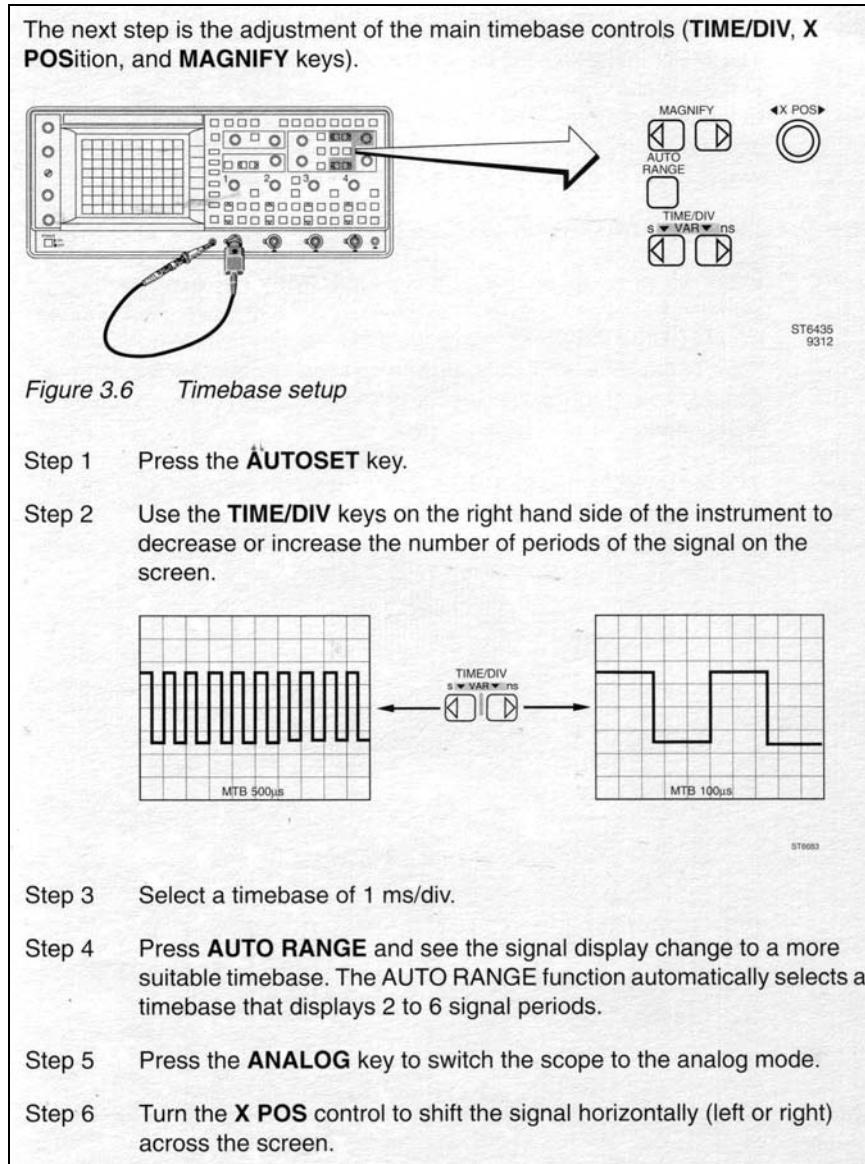
**AUTOSET FUNCTION**

Figure 3: Fluke PM3380A User Manual page 5-10<sup>[1]</sup>

Press the **AUTOSET** oscilloscope. Adjust the **TRACE INTENSITY**, **FOCUS**, etc., if desired. Notice that information is provided on the screen. The basic information being displayed is Ch1 and Ch2 volts/div and whether or not the signals being displayed are the AC signal, the total signal, or ground. Also the seconds/div is displayed for both waveforms. This will be discussed later. Note that the function generator screen provides information on the type of waveform at the output, frequency, PP voltage or the DC offset voltage. Also, there is other information on functions that we will not be using this semester. We will set the function generator so that it is at a 4Vpp (peak-to-peak) sine wave at 1kHz. First, we will adjust the frequency to 1kHz. The frequency can be adjusted selecting the left or right frequency buttons, and then manipulating these buttons along with the  $\div 10$ ,  $\times 10$ , and turning the knob. Figuring what each button and the knob does is quite simple and just takes a few minutes. The left and right buttons flash one digit on the display of the function generator. Turning the knob left or right changes this value. By using these buttons, you may select which digit you would like to adjust. Pushing the  $\div 10$  and  $\times 10$  cause the output frequency to be multiplied by 10 or divided by 10. Effectively, this gives you a new range of frequencies to work with. Play with this until you feel comfortable with the operation of these and the selection of an arbitrary frequency. While you are getting familiar with these, observe the waveforms on the scope. When you are through, select the frequency of the function generator to 1kHz.

TIMEBASE SETUPFigure 4: Fluke PM3380A User Manual page 3-11<sup>[1]</sup>

Adjust the **TIME/DIV** so that the waveforms "looks good". This can be accomplished by pushing the left and right buttons underneath the **TIME/DIV** heading. You may also want to adjust the **X POS**. This is done by turning the **X POS** knob left or right. Adjust this so that your waveform "looks good". After you have accomplished this, first push the left button twice and then right button twice, while observing the waveforms on the screen. Describe what happens to the wave form when the left and right buttons are pushed, and based our "model" for the scope, what is happening internally. Note also that at the bottom of the screen, the words "CHP MTB 500us" or some value other than 500us appears. This means that the scaling on the horizontal display is 500us/div. Adjust the scope so that it reads 200us. We will discuss CHP later.

Next we will select the waveform of the function generator to be a signwave, although more than likely it is a sinewave already. The function generator is capable of generating many different types of waves. The wave selected can be accomplished by pushing the left or right buttons underneath the **WAVEFORM** heading. The first time you push either, the function generator enters the select waveform mode. This shows the various waveforms you may

select. The blinking waveform is the currently selected waveform. Thereafter, you may select any of the waveforms you desire by pushing the right or left buttons. You should select each waveform and observe them on the scope. Finally, select the sinewave.

### VERTICAL SETUP

This section deals with setting of the input circuits of the four channels. The main adjustments are **AMPLitude**, **POSition**, and the channel input coupling selection for **GND**, **DC**, and **AC**.

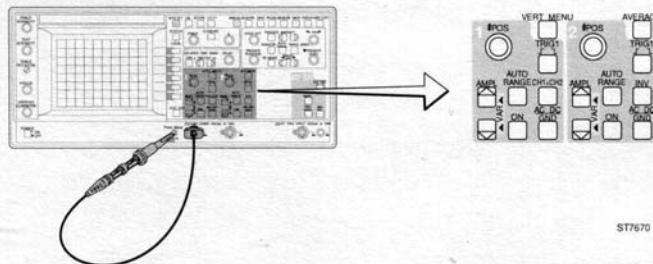
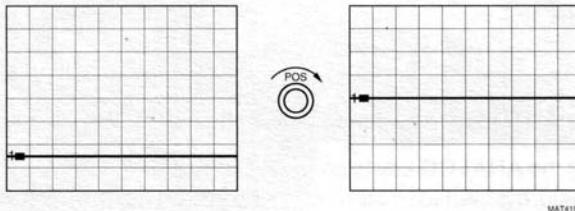
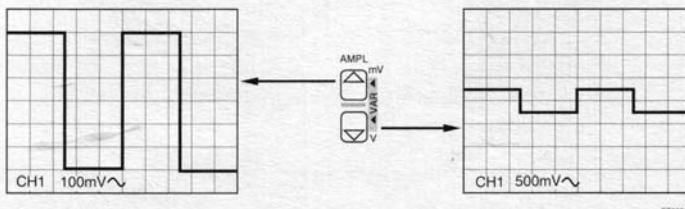


Figure 3.5 Vertical setup

Step 1 Adjust the absolute ground level by disconnecting the signal and using the **POS** control to position the trace in the middle of the screen. A marker with the channel number ('1-') at the left of the screen indicates the ground reference.



Step 2 Reconnect the probe to the Probe Adjust signal for display.  
 Step 3 You can change the amplitude of the signal in a 1, 2, 5 sequence by pressing one of the **AMPL** keys. Note that the bottom of the screen shows the **AMPL/DIV** setting of CH1.



Step 4 Press the **ON** button of CH2 and observe that a second trace is now visible. The position and amplitude of this channel can be adjusted similar to the adjustment of CH1. The channel settings are also displayed in the bottom of the screen.

Press the **ON** key of CH2 once again to turn this channel off.

Figure 5: Fluke PM3380A User Manual page 3-8<sup>[1]</sup>

Next we will adjust the wave so that it is 4Vpp. This is done by pressing the **AC** button to select this option. From here, it is similar to adjusting the frequency. The only options we have, however, are to select the  $\div 10$ ,  $\times 10$ , and

turning the knob. Get familiar with the operation of this. When you are through, select the waveform to be 4Vpp. Now we need to adjust the scope display (maybe). This done by selecting the up or down buttons underneath the **AMPL** function of Ch1. Note the functions corresponding to only Ch1 or Ch2 are "grayed out", side-by-side, and numbered 1 or 2. Adjust the waveform so that it "looks good". After you have accomplished this, first push the up button twice and then down button twice, while observing the waveforms on the screen. Describe what happens to the waveform when the up and down buttons are pushed, and based our "model" for the scope, what is happening internally. Note, of course, on the scope, both Ch1 and Ch2 have **AMPL** functions.

Add a DC Offset of 1V to the sinewave. This is accomplished by selecting the **DC** function on the function generator. By now, it should be self-explanatory on setting the function generator properly to accomplish this. Note that there should be no changes in the waveforms on the scope if you have done everything properly to here, with the exception of a little movement.

Adjust Ch1 so that it at 1V/div. In the left hand corner, you should have "CH1 V-(the sine wave indicates that Ch1 is in the AC mode. For each channel, there are three modes, or three types of coupling, in which the vertical amplifier may be placed. The first is AC coupling. This means the dc portion of the waveform is filtered out, and only the timevarying signal is passed.

**Step 5** Press the **AC DC/GND** key of CH1 so that a 'L' sign is displayed in the bottom text line. This interrupts the input signal and connects the input to the ground. In this case, only the 'base' line is visible.

Press the **AC DC/GND** key once again for ac input coupling; the bottom text line now displays '~'.

In most cases, dc input coupling is used to show ac as well as dc components of the signal. However, in some cases where a small ac signal is superimposed on a large dc voltage, ac input coupling must be used. Then only the ac component is visible on the screen. The text line shows a '=' or '~' sign to indicate dc or ac coupling. Because the calibration signal is a square wave with a low level of 0V and a high level of +600 mV, the screen shows either of the following two displays:

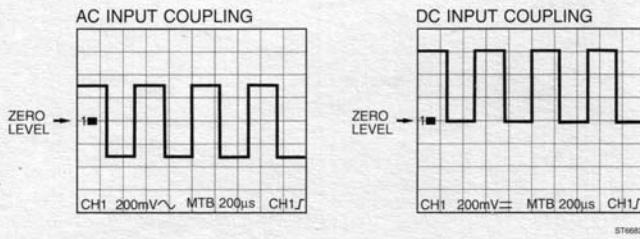


Figure 6: Fluke PM3380A User Manual page 3-9<sup>[1]</sup>

Press the **AC/DC/GND** button for Ch1. The coupling indicator should now read "Ch1 V=". The scope is now in the directly coupled mode. This means the entire signal is now being displayed on the scope.

Press the **AC/DC/GND** button for Ch1 again. Ch1 is now in the **GND** mode. This means that the input is grounded and the straight line represents 0V. This is useful for placing your reference, or ground at an arbitrary point. Adjust your ground line with the **POS** knob so the ground line is place directly on the center horizontal line.

Place Ch1 back to **DC** coupling. Carefully sketch the waveform for Ch1. Based on the number of divisions for Vpp and the offset and the setting in Volts/division, is the waveform what you would expect.

Place Ch1 in AC coupling.

### TRIGGERING

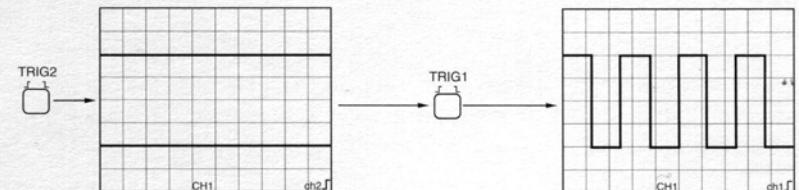
TRIGGER	SOURCE
<ul style="list-style-type: none"> <li>Press the TRIG 2 key in the CH2 section of the front panel to select channel 2 as trigger source.</li> </ul> <p>The indication in the lower right hand readout area of the screen now displays 'ch2'. Observe that the signal is not triggered. The ARM'D LED is on.</p> <ul style="list-style-type: none"> <li>Press the TRIG 1 key in the CH1 section of the front panel to select channel 1 as trigger source.</li> </ul> <p>Observe that the indication has now changed into 'ch1' and the signal is triggered again.</p> 	

Figure 7: Fluke PM3380A User Manual page 4-26<sup>[1]</sup>

In the lower right half of the screen, note the word Ch# and a symbol. The Ch# means that the CH1 and CH2 signals are triggered by Ch#. press the **TRIG 1** button.

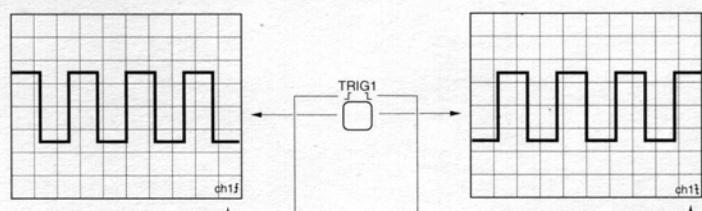
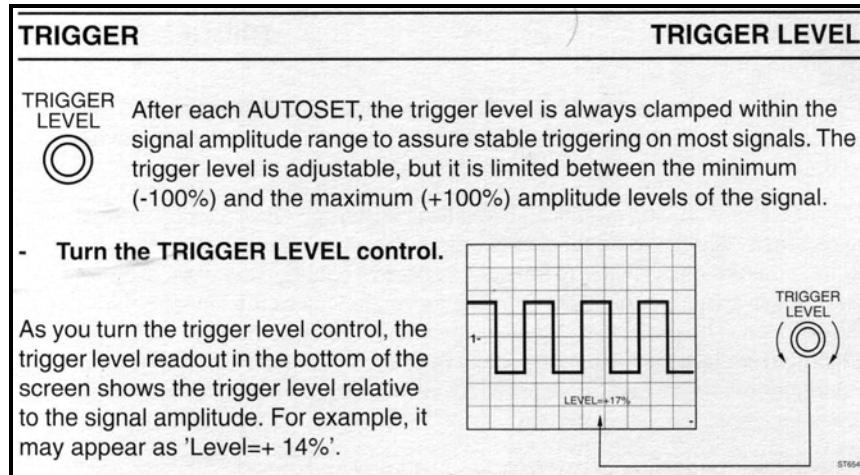
TRIGGER	SLOPE
 <p>The trigger source selection key is also used to select the trigger slope between the positive-and negative-going edge of the triggering signal.</p> <ul style="list-style-type: none"> <li>Press the TRIG 1 key in the CH1 section of the front panel a second time.</li> </ul> <p>Observe that the signal now starts with the trailing edge instead of a leading edge. Also the trigger slope symbol in the lower right hand corner of the readout area indicates a trailing edge.</p> 	

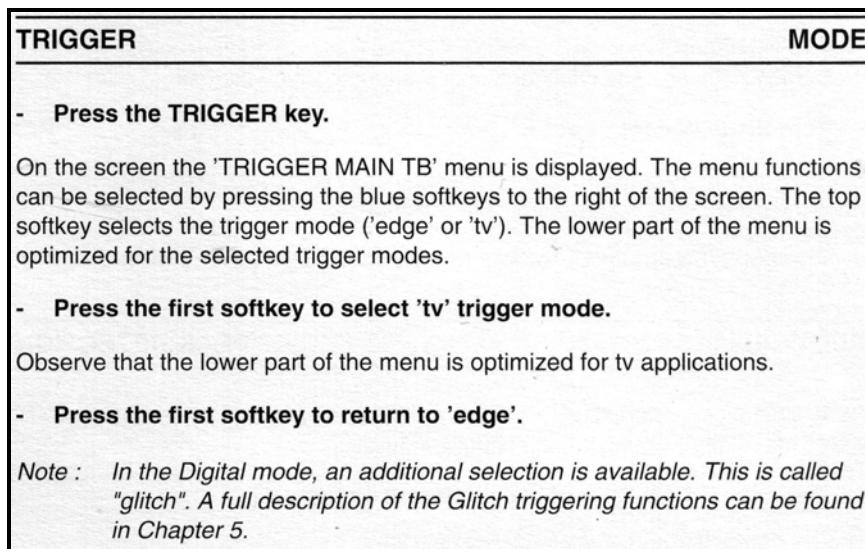
Figure 8: Fluke PM3380A User Manual page 4-26<sup>[1]</sup>

Change the triggering of Ch1 to trigger on the positive slope.

Note that in analog mode, triggering determines the point the sweep begins. In digital mode, it determines the point in the waveform the trace is acquired and placed into memory.

Figure 9: Fluke PM3380A User Manual page 4-27<sup>[1]</sup>

Set trigger level to 0%.

Figure 10: Fluke PM3380A User Manual page 4-34<sup>[1]</sup>

Press the **TRIGGER** button found in the upper right quadrant of the scope panel. Note the "TRIGGER MAIN TB" menu that appears on the right hand side of the screen. The description of this menu follows.

The first choice is whether or not the edge triggering or tv triggering is used. Edge should be highlighted here. The tv option allows triggering from video frames from various TV standards. TV triggering is beyond the scope of our course. Using the soft key just to the right of the option, change from edge triggering to tv triggering and back to edge triggering.

The next set of modes shows the following: Ch1, ext. trig or line. This allows the user to trigger from various signals. Use the soft key found just to the right to trigger the circuit from an external signal. The external signal used is the signal applied at the lower right hand side BNC connector. Since we have no applied signal there is nothing triggering the waveforms.

### 1. Describe what is happening on the screen and why you think this is happening.

Now remove the output of the PM5139 from Ch1 to Ext. Trig input. For the Ext Trig, push the **TRIG VIEW**. Note the sine wave is now displayed on the screen. Press **AMPL** in the Ext Trig section to adjust the amplitude. Not that by now, the waveforms on the screen are now "well behaved". For Ext. Trig, press **AC/DC** several times.

## 2. What is the function of this button?

Remove the output of the PM5139 and place back at Ch1. Press the softkey once more to trigger from the line.

## 3. Describe what is happening on the screen and why you think this is happening?

Finally, set the scope so that it triggers from Ch1 again.

You may also trigger from Ch2. This is accomplished by simply pushing the **TRIG 2** button found in the Ch2 section. Push this button and note change in the display of the trigger information.

## 4. Sketch the waveforms, describe the changes that occur, and discuss what has happened.

Set the scope to trigger from Ch1.

**TRIGGER** **LEVEL**

- Press the 'level-pp' softkey to turn it off.

**TRIGGER LEVEL** The automatic level detection circuitry is turned off. The trigger level is no longer clamped within the peak-peak range of the signal. You must adjust the proper trigger level. While you turn the TRIGGER LEVEL control, the actual trigger level is displayed in (m)V.

An indicator 'T-' is displayed next to the channel identifier when the combination of trigger coupling and channel input coupling is useful (both ac coupled or both dc coupled).

When the 'T-' is within the signal range, a stable display of the signal is obtained. When proper triggering takes place, the ARM'D LED is off.

Use the TRIGGER LEVEL control to move the indicator (T-) vertically.



When the trigger level indicator (T-) is outside the signal range, triggering is lost. Because of the nature of the (Probe Adjust) input signal, it appears that only two lines are drawn. The timebase is not properly triggered, as is indicated by the ARM'D LED being turned on.

*Note: 'T-' is an indication for reference only. Its position can differ slightly from the actual trigger level.*

Figure 11: Fluke PM3380A User Manual page 4-35<sup>[1]</sup>

The next set of commands gives information on the level, or voltage at which the signal is to be triggered. At this point, the display should say "level-pp on". This means that the level range is clamped within the peak-to-peak values of the triggering waveform. Note the **TRIGGERING LEVEL** knob on the right hand side of the scope. This allows

you to vary the voltage at which the signal is triggered. Turn the clockwise. Note that as you turn, information on the level is displayed at the bottom of the screen. While observing the waveforms on the scope, turn the **TRIGGERING LEVEL** until the level is at +100%. Then turn until the level is at -100%, and finally back to 0%. Carefully describe the changes the waveform is undergoing and why it is happening.

By pushing the associated softkey, turn the level-pp off. This allows for triggering to be set in terms of an actual voltage. Turn the **TRIGGERING LEVEL** knob to adjust the waveform to trigger at 1V. Note the changes in the waveform. Now adjust the triggering voltage so the waveform triggers at 2.5V.

## 5. Describe what is happening to the waveform and why it is happening.

Set the scope so the level-pp is on and the triggering occurs at 0%.

Noise: The next item on the menu is noise on off. The off should be highlighted. This allows for noise to be filtered out in situations where the noise may cause triggering problems. Turn the noise on and off again.

## 6. Describe any changes and tell what is happening, (or why nothing may be happening).

The next item on the menu is triggering on the positive slope or the negative slope. This is just another way to choose the triggering edge and is identical to how it is done for Ch1 and Ch2. Press the softkey twice for verification.

The last item on the menu allows for the trigger signal to be coupled in different modes. Note that we have ac, dc, lf-rej, and hf-rej. The filter modes ac and dc are identical to the coupling modes as described for Ch1 and Ch2. The lf-rej mode filters out signals below 30kHz for triggering. The hf-rej mode filters out signals above 30kHz for triggering. Place the triggering in the lf-rej mode.

## 7. Describe what is happening and why.

Place the triggering in the hf-rej mode.

## 8. Describe what is happening and why.

Finally, place the trigger coupling back in the ac mode.

Place the scope in the digital mode. Note that digital mode allows for "glitch" triggering in addition to edge and tv triggering. Glitch triggering is a special type of triggering that is beyond the scope of our course. Turn the scope back to the analog mode.

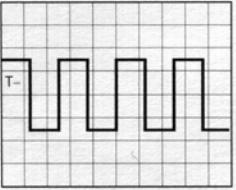
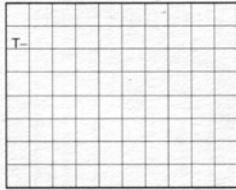
TRIGGER MODE	TRIGGERED
<ul style="list-style-type: none"> <li>- Press the TB MODE key.</li> </ul> <p>TB MODE <input type="checkbox"/> In the screen, the timebase mode (TB MODE) menu appears. 'auto' is intensified. With the "auto" mode turned on, the timebase will run free as soon as no triggering signal is detected, in order to provide a base line. The 'Auto' mode works well with most signal that have frequencies of 30 Hz or higher.</p>	
<ul style="list-style-type: none"> <li>- Press the softkey next to the 'auto trig single' function to select 'trig'.</li> </ul> <p>In the triggered mode, a signal is visible only when proper triggering occurs.</p>	
<ul style="list-style-type: none"> <li>- Move the indicator (T-) in and out of the signal range.</li> </ul> <p> </p>	
<p>In the <b>Analog</b> mode, the result is a stable and triggered signal when the indicator is inside the signal range, and no trace appears on the screen when the indicator is outside the signal range.</p> <p>Disabling the 'auto' function by selecting 'trig' can be useful for displaying very low frequency signals. The scope waits for a real trigger before the sweep starts even if the signal frequency is very low.</p> <p>In the <b>Digital</b> mode, the same criteria exist for the use of the 'auto' function and the 'trig' function, but there is a difference. When the scope is in the 'trig' mode and triggering is lost, the acquisition will stop, but the display will reflect the last information before the triggering stopped. This may lead you into thinking that the scope is properly triggered because the display appears to be stable, while in fact, you are displaying stored information only. Watch the ARM'D LED !</p>	

Figure 12: Fluke PM3380A User Manual page 4-36<sup>[1]</sup>

Press the **TB MODE** button found in the upper right quadrant of the scope panel. Note the "TB MODE" menu that appears on the right hand side of the screen. The description of this menu follows.

In the first set of commands, we have auto, trig, or single mode. In auto mode, a display is always present. In trig mode, a display is present only when MAIN TB is triggered by a signal. In single mode, only one sweep is displayed when the MAIN TB is triggered. The MAIN TB can be triggered by pressing the **SINGLE** button in the right hand side. Place the scope in single mode. Press the **SINGLE** button several times.

## 9. Describe what is happening and why.

When you are finished, place the scope back in the auto mode. The single mode is used to capture and display events that only happen once.

Set the scope to trigger at 2.5V. Make sure the coupling for Ch1 is AC. Set the TB mode to trig.

## 10. Describe what happens and why.

Set the TB MODE back to auto and set the scope back to triggering at 0%.

Last on the TB MODE menu is alt or chop. Alt (Alternate Sweep) means that Ch1 and Ch2 are displayed in alternate sweeps. CHP (Chopped Sweep) means that a part of Ch1 is swept, then a part of CH2, until both are completed. The picture below illustrates the difference between CHP and ALT.

Change the scope to digital mode. Note the TB Menu allows for several more functions. We will not discuss those here. Place the scope back in analog mode.

Determine the operation of the **CH1 + CH2** and **Ch2 INV**.

#### CURSORS

The last thing we will discuss, is the measuring of waveforms with the cursors. Press the **CURSORS** button found in the upper left hand quadrant. Note the CURSORS menu that appears on the screen. Make sure that Ch1 is at 1V/div, Ch2 is at 2V/div, and both are AC coupled.

The first set of commands indicates that the horizontal cursors, vertical cursors, or both appear. Select each of these functions and verify that different sets of cursors appear. When you are through, select the horizontal cursors to measure Ch1.

Initially, the cursor track mode is enabled. Locate the **TRACK** and  $\Delta$  knobs. Turning the **TRACK** moves both cursors. Turning  $\Delta$  moves one cursor. Adjust the cursors with these controls so that one is place on the peak value of the waveform, and one is at the minimum of the waveform. In the upper left half portion of the screen, the information Ch1:  $\Delta V=4.05V$  appears. At least mine says 4.05V, yours may be slightly different. What happens is that the scope measures the number of divisions difference between the 2 cursors. It then calculates a voltage from this by multiplying the setting of Ch1, 1V/div and giving out the appropriate answer.

Below the cursor indicator, is a Ch1 and Ch2. Select Ch2. Describe what happens and why. Select Ch1 again.

Select the vertical cursors. Using the **TRACK** and  $\Delta$  measure the difference between two of the peaks. The value in the upper left hand corner now gives the time difference between the cursors. This of course is the period of the waveform.

**11. From the measured period, calculate the measured frequency of the sinewave.**

Now press the readout function on the menu. Note that different information can be displayed. Using the softkeys, select  $1/\Delta T$ ,  $\Delta T$ -ratio, and ph.

**12. For each of these, write down the new information being given and thus tell the function of each selection.**

When you are through, select the  $\Delta T$ .

Note also here that cursor tracking may be turned off. This allows for both cursors to be independently adjusted. Select no for cursor tracking. Now varying the **TRACK** and  $\Delta$ .

**13. What is happening?**

Select cursor tracking again.

Select the horizontal cursors again. Select READOUT. Now select  $\Delta V$ , V1, V2, and  $\Delta V$ -ratio. For each of these, write down the new information being given and thus tell the function of each selection. When you are through, select the  $\Delta V$  again

Last select the #. Now, both sets of cursors are available. Note the CONTROL setting. You have a choice between the **TRACK** and  $\Delta$  control the vertical or horizontal cursors. Select both and verify operation of this function.

We will discuss only the analog mode here. If you have time, you should pursue some of the digital functions.

You have completed a tutorial of the oscilloscope. It is by no means complete, but it should provide you with a good solid basis for understanding how to use it properly. If time permits, we will include the delay functions which we did not cover here. We will periodically add to your knowledge of the oscilloscope. We will not ask you to include this portion in the report. We would like you to answer the questions asked during the tutorial and turn this in. It is important that you answer the questions properly. We will periodically quiz you on your knowledge of the oscilloscope.

### **Report:**

Answer the numbered questions. This does not need to be typed; however, write neatly.

### REFERENCES

[1] Fluke Corporation, "Autoranging CombiScope Instrument PM3380 User Manual" Copyright 1994